NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

GRADE STABILIZATION STRUCTURE

(No.)
CODE 410

DEFINITION

A structure used to control the grade and head cutting in natural or artificial channels.

PURPOSE

To stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

CONDITIONS WHERE PRACTICE APPLIES

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. Special attention shall be given to maintaining or improving habitat for fish and wildlife where applicable.

This standard applies to all types of grade stabilization structures, including a combination of earth embankments and mechanical spillways and full-flow or detention-type structures. This standard also applies to channel side-inlet structures installed to lower the water from a field elevation, a surface drain, or a waterway to a deeper outlet channel.

CRITERIA

All structures must be designed for stability after installation. The crest of the inlet must be set at an elevation that stabilize upstream head cutting. Downstream erosion must be controlled by containing erosive exit velocities within the limits of the structure.

Laws and Regulations. All structures planned and installed under this practice must conform to all applicable Federal, State and local laws and regulations. The design and construction of dams shall be in compliance with all State of Idaho Water Laws and Regulations, including State of Idaho Department of Water Resources, “Safety of Dam Rules and Regulations”.

Embankment Dams. Class (a) dams that have a product of storage times the effective height of the dam of less than 3,000 and an effective height of 35 ft. or less shall meet or exceed the requirements specified for Conservation Practice Standard, Ponds (378). If mechanical spillways are required on this size and class of dams, the minimum capacity of the principal spillway shall be that required to pass the peak flow expected from a 24-hour duration design storm of the frequency shown in Table 1, less any reduction because of detention storage. If criteria values exceed those shown in Table 1 or the storage capacity is more than 50 acre-feet, the 10-year frequency, 24-hour duration storm must be used as the minimum design storm.

Class (a) dams that have a product of storage times the effective height of the dam of 3,000 or more, those more than 35 ft. in effective height, and all class (b) and class (c) dams shall meet or exceed the requirements specified in NRCS, Technical Release No. 60 (TR-60), “Earth Dams and Reservoirs”.

The NRCS effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

Grade stabilization dams with a settled fill height of less than 10 feet and 10-year frequency 24-hour storm runoff of less than 10 acre-feet, shall be designed to control no less than a 10-year frequency storm without overtopping. The mechanical spillway, regardless of size, may be considered in design and an emergency spillway is not required if the combination of storage and mechanical spillway discharge will handle the

design storm. The embankment can be designed to meet the requirements for Conservation Practice Standard, Water and Sediment Control Basins (638) rather than the requirements for Ponds (378).

Table 1. - Design Criteria For Establishing Minimum Capacity Of The Principal Spillway For Dams With Storage Capacity Of Less Than 50 Acre-Feet.

Maximum drainage area for indicated rainfall[1]		Effective height of dam	Frequency of minimum design, 24-hour duration storm
0-3 in.	3 - 5 in.		
----------*acres*----------		*feet*	*Year*
200	100	35 or less	2
400	200	20 or less	2
400	200	20 - 35	5
600	400	20 or less	5

[1] In a 5-year frequency, 24-hour duration storm, Reference: NOAA Atlas No. 2, Volume V, Idaho

Full-flow open structures. Drop, chute, and box inlet drop spillways shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices, the National Engineering Handbook, Conservation Practice Standard, Structure for Water Control, (587) and other applicable NRCS publications and reports. The minimum capacity flow through type structures shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction because of detention storage. If site conditions exceed those shown in Table 2, the minimum design 24-hour storm frequency is 25 years for the principal spillway and 100 years for the total capacity. Structures must not create unstable conditions upstream or downstream. Provisions must be made to insure reentry of bypassed storm flows.

Toe wall drop structures can be used if the vertical drop is 4 feet or less, flows are intermittent, downstream grades are stable, and tail water depth at design flow is equal to or greater than one-third of the height of the overfall.

The ratio of the capacity of drop boxes to road culverts shall be as required by the responsible road authority or as specified in Table 2 or 3, as applicable, less any reduction because of detention storage, whichever is greater. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

All structures shall be designed to meet specific site conditions and functional requirements. Measures to prevent water piping through the soil foundation, abutments or structure shall be designed and installed where necessary. Structures shall be designed with adequate keyways into the channel banks and bottom.

Refer to NEH, Part 639, ASAE Paper 972062, “Design of Rock Chutes” for typical rock chute design information.

Rock drop structures and combination log crest and rock apron type flow through structures may be used in series to effectively control head cuts. The effective drop in any structure should not exceed 2 feet and shall not exceed 4 feet.

Geotextile fabric material or a sand/gravel bedding/filter shall be placed between earth and rock/log surfaces unless the existing soil materials meet the requirements for a filter.

Combination rock and brush structures may be used subject to the following limitations: (a) drainage area less than 200 acres (b) channel slope less than 6 percent (c) height from crest of structure to low point in channel along structure is 4 feet or less. The minimum apron length shall be at least 2 times the height of the drop through the structure. The crest width of rock and brush structures shall be at least equal to the height. Structures in series shall be spaced so the design drop of a structure is elevation from weir to weir of next downstream structure. Structures shall be keyed a minimum of 2 feet into the channel banks and a minimum of 1 foot into the channel bottom.

Table 2. - Design Criteria For Establishing Minimum Capacity Of Full-Flow Open Structures.

Maximum drainage area for indicated rainfall[1]		Vertical drop	Frequency of minimum design, 24-hour duration storm	
0 - 3 in.	3 - 5 in.		Principal spillway capacity	Total capacity
----------acres----------		*Feet*	*Year*	*Year*
1,200	450	5 or less	5	10
2,200	900	10 or less	10	25

[1]In a 5-year frequency, 24-hour duration storm.

Island-type structures. If the mechanical spillway is designed as an island-type structure, its minimum capacity shall equal the capacity of the downstream channel. For channels with very small drainage areas, the mechanical spillway should carry at least the 2-year, 24-hour storm or the design drainage curve runoff. The minimum emergency spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2 for total capacity without overtopping the headwall extensions of the mechanical spillway. Provision must be made for safe reentry of bypassed flow as necessary.

Table 3. - Design Criteria For Establishing Minimum Capacity Of Side-Inlet, Open Weir, Or Pipe-Drop-Drainage Structure.

Maximum drainage area for indicated rainfall[1]		Vertical drop	Frequency of minimum design, 24-hour duration storm	
0 - 3 in.	3 - 5 in.		Receiving channel depth	Total capacity
----------acres----------		*feet*	*feet*	*Year*
1,200	450	0 - 5	0 - 10	--
1,200	450	5 - 10	10 - 20	10
2,200	900	0 - 10	0 - 20	25

[1]In a 5-year frequency, 24-hour duration storm.

Side-inlet drainage structures. The design criteria for minimum capacity of open-weir or pipe structures used to lower surface water from field elevations or lateral channels into deeper open channels are shown in Table 3. The minimum principal spillway capacity shall equal the design drainage curve runoff for all conditions. If site condition values exceed those shown in table 3, the 50-year frequency storm shall be used for minimum design of total capacity.

General criteria. Earth embankment and emergency spillways of structures for which criteria are not provided under the Conservation Practice Standard for Ponds (378) or in TR-60 must be stable for all anticipated conditions. If earth spillways are used, they must be designed to handle the total capacity flow indicated in Tables 2 or 3
without overtopping the dam. The foundation preparation, compaction, top width, and side slopes must ensure a stable dam for anticipated flow conditions. Discharge from the structure shall be sufficient that no crop damage results from flow detention.

Necessary sediment storage capacity must equal the expected life of the structure, unless a provision is made for periodic cleanout.

Safety. The earth embankment pond structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life. Protective guardrails, warning signs, fences, or lifesaving equipment shall be added as needed.

If the area is used for livestock, the structures, earthfill, vegetated spillways, and other areas should be fenced as necessary to protect the structure. Near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers.

Landscape resources. In highly visible public areas and those associated with recreation, careful considerations should be given to landscape resources. Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat. Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

Protection. The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary to prevent erosion. If climatic conditions preclude the use of vegetation, nonvegetative coverings such as gravel or other mulches may be used.

Materials. Concrete, metal and wood materials shall meet the general requirements as listed in Conservation Practice Standard, Structure for Water Control, 587, for the respective material. Rock shall be durable.

CONSIDERATIONS

Effects on volumes and rates of runoff, evaporation, deep percolation and ground water recharge.

Effects of the structure on soil water and resulting changes in plant growth and transpiration.

Ability of structure to trap sediment and sediment-attached substances carried by runoff.

Effect of structure on the susceptibility of downstream stream banks and streambeds to erosion.

Effects of the proposed structure on the movement of dissolved substances to ground water.

Effects on visual quality of downstream water resources.

When selecting the design storm frequency at a particular site, consider the potential hazards from damage or failure of the structure during larger runoff events. Select design storm frequency considering construction costs, Operation and Maintenance and replacement costs and potential damages.

PLANS AND SPECIFICATIONS

Plans and specifications for installing grade stabilization structures shall be in keeping with this standard and shall describe the material requirements and installation details for applying the practice to the required lines and grades to achieve its intended purpose.

OPERATION AND MAINTENANCE

A site specific O&M plan must be prepared for and reviewed with the landowner or operator. The plan shall contain guidance to maintain the embankment, structure design capacity, replace displaced rock, vegetative cover and remove debris from structure(s).

All plans shall include a provision that after each large storm, structures must be inspected and needed maintenance performed. When design sediment storage is filled, accumulated sediment must be removed or the basin must be redesigned and modified to restore capacity.

Where designs include pipes, O&M plans shall include checking for clogging and/or pipe damage.